3.7 WATER RESOURCES

This chapter focuses on water resource issues specific to U. S. Army facilities and operations within three interrelated geographic areas: the upper Hueco Bolson, the lower Tularosa Basin, and the western Salt Basin.

The upper Hueco Bolson is that part of the Hueco Bolson that lies northeast of the Rio Grande. It extends north from El Paso County, Texas, to parts of Doña Ana and Otero counties in south central New Mexico. The Bolson is bounded on the east by the Hueco Mountains and Otero Mesa, and on the west by the Franklin and Organ mountains (Figure 3.0-1). A gentle topographic rise, 5 to 10 miles north of the New Mexico-Texas state line, separates the basin from the geologically similar Tularosa Basin to the north (Orr and White, 1985). The topographic divide, however, is not the groundwater divide (Knowles and Kennedy, 1956), and the New Mexico State Engineer defined the north boundary of the Hueco Groundwater Basin about 20 miles north of the state line. This designation effects only the southwest corner of the Tularosa Basin; the Hueco Groundwater Basin, as defined, does not extend eastward onto McGregor Range. Geologically, however, the Hueco Bolson in New Mexico extends eastward to the Hueco Mountains and Otero Mesa. This administrative rather than physical demarcation resulted from applications for groundwater withdrawals by the City of El Paso north of the New Mexico-Texas state line (Chudnoff, l997). U.S. Army facilities in the Upper Hueco Bolson include: the McGregor Range Camp, the Doña Ana Range–North Training Areas Camp, and related military facilities.

The Tularosa Basin encompasses approximately 6,500 square miles in south-central New Mexico and includes parts of Otero, Doña Ana, Otero, and Lincoln counties. Alamogordo, in Otero County, is the principal center of population. Military installations in the area are HAFB, WSMR, and in the southern part of the basin, McGregor Range and the Doña Ana—North Training Areas of Fort Bliss. The area also includes White Sands National Monument, managed by the National Park Service, and large tracts of federal lands managed by the BLM. Only the lower part, roughly the southern third, of the basin is within the McGregor Range ROI (Figure 3.0-1). The lower Tularosa Basin is bounded on the east by the Sacramento Mountains and Otero Mesa, and on the west by the Organ and San Andres mountains. On the south, the basin is contiguous with the geologically similar upper Hueco Bolson.

Roughly the northeast quarter of McGregor Range, including the southern slopes and foothills of the Sacramento Mountains and the western part of Otero Mesa, is within the Salt Basin, listed as an undeclared groundwater basin by the New Mexico State Engineer. At the west side of Otero Mesa a 500- to 1,000-foot escarpment separates the mesa from the floor of the Hueco Bolson. The escarpment extends north from the Hueco Mountains to the Sacramento Mountains. The basin is bounded on the east by the Guadalupe Mountains and extends from Otero County, New Mexico, south into Texas. The Salt Basin contains no population centers in the McGregor Range vicinity.

3.7.1 Surface Water

The mountain slopes and foothill areas around the margins of the Hueco Bolson are characterized by small intermittent and ephemeral streams (arroyos) which, during periods of heavy or prolonged storms, discharge onto the bolson floor, where the runoff infiltrates or is lost to evapotranspiration. No well-defined natural drainage channels are present on the bolson floor in New Mexico. Surface water that originates in the upper Hueco Bolson is not considered an adequate or dependable source of supply.

The Tularosa Basin is characterized by small streams and arroyos, which occasionally discharge to the central part of the basin, where the water is contained in shallow ephemeral lakes (playas). Several playas have become permanent features, including Lake Lucero in the lower basin. Many of the surface water drainages that originate in the mountains are perennial in their upper reaches and support wetlands and aquatic wildlife. These and many of the ephemeral streams are classified by the U.S. Army Corps of Engineers (USACE) (U.S. Army, 1996d) as probable Waters of the U.S (Figure 3.7-1). To qualify as a USACE jurisdictional wetland, it must have hydric soil, be saturated to the surface sometime during the growing season, and contain wetland plant species. Waters of the U.S. includes "water such as intrastate lakes, rivers, streams (including intermittent streams)" (33 CFR 328.3(a)[3]). The exact boundary of the Waters of the U.S. will be delineated for site-specific projects and a final determination by the USACE district engineer is needed before a jurisdictional determination is complete. A total of 1,291 dry washes with distinct streambeds and sides comprising 2,475 miles were mapped on McGregor Range. In addition, thirteen intermittently flooded lakes with distinct ordinary high water marks totaling 132 acres and 110 artificial water resources (691 acres) including sewage lagoons, storm-water retention basins, and cattle tanks were mapped on McGregor Range (U.S. Army, 1996a). Ranchers historically have captured and developed surface water for livestock in most of these streams. Under normal conditions, the mountain drainages are not tributary to larger streams. No significant volume of surface water is discharged from the basin.

The Salt Basin watershed in McGregor Range includes the western part of the Otero Mesa and the southern slopes and foothills of the Sacramento Mountains. Similar to the Tularosa Basin, the Salt Basin is characterized by small ephemeral streams that discharge toward the central areas of the basin (see Figure 3.7-1). Virtually all stream channels in the Sacramento Mountains and Otero Mesa on McGregor Range are classified as probable Waters of the U.S. by the USACE (U.S. Army, 1996d). Under natural conditions, small playas would develop in low-lying areas during periods of high runoff; however, earthen dams now capture most of the available water for livestock. A few streams are perennial in their upper reaches outside the boundary of McGregor Range. However, the Sacramento River, prior to the installation of upstream diversions, probably was perennial for at least part of its course through McGregor Range. Three such diversions capture water for use on McGregor Range and the adjoining community of Oro Grande. The diverted water is transported, via three pipelines: one crosses the northwest quarter of McGregor Range to Oro Grande, and the other two supply water to numerous tanks and troughs across Otero Mesa (Figure 3.7-2). Figure 3.7-3 shows the earthen impoundments on McGregor Range. The U.S. Army holds Water Right Number 10652 for the diversion. The water is used by livestock as well as wildlife. This right entitles the Army to divert 60,000 gpd of surface water flow from the Sacramento River and 50,000 gpd from Carrisa Springs. The stated beneficial use of the Army's water right was changed to "for the preservation of fish and wildlife" from "livestock and domestic purposes" in 1963.

The McGregor pipeline system (exclusive of the Oro Grande system) is a large gravity-fed water network that is operated, and maintained by the BLM for wildlife and livestock. The system has been in existence since the early 1900s and has been modified, expanded, and relocated extensively since then, mostly in piecemeal fashion. The three intakes for the system are in the Sacramento Mountains, north of McGregor Range. Two lines feed Rim Tank, an open reservoir with a capacity of 2 million gallons, on the north boundary of McGregor Range. The system is designed to gravity flow from this reservoir, or bypass it, into the McGregor pipeline—a 65-mile trunk and branching system that feeds several branches and lines in the Sacramento Mountains foothills and the western part of Otero Mesa. A smaller independent system, the El Paso line, runs through El Paso Canyon to the east boundary of McGregor Range in the north part of Otero Mesa (BLM, 1985). Deliveries by the two systems are reported at 60 to 65 gpm (about 100 afy) (Christensen, 1998).

3.7.2 Groundwater

Groundwater at McGregor Range is discussed by geographic area: the Upper Hueco Bolson, Lower Tularosa Basin, and western Salt Basin.

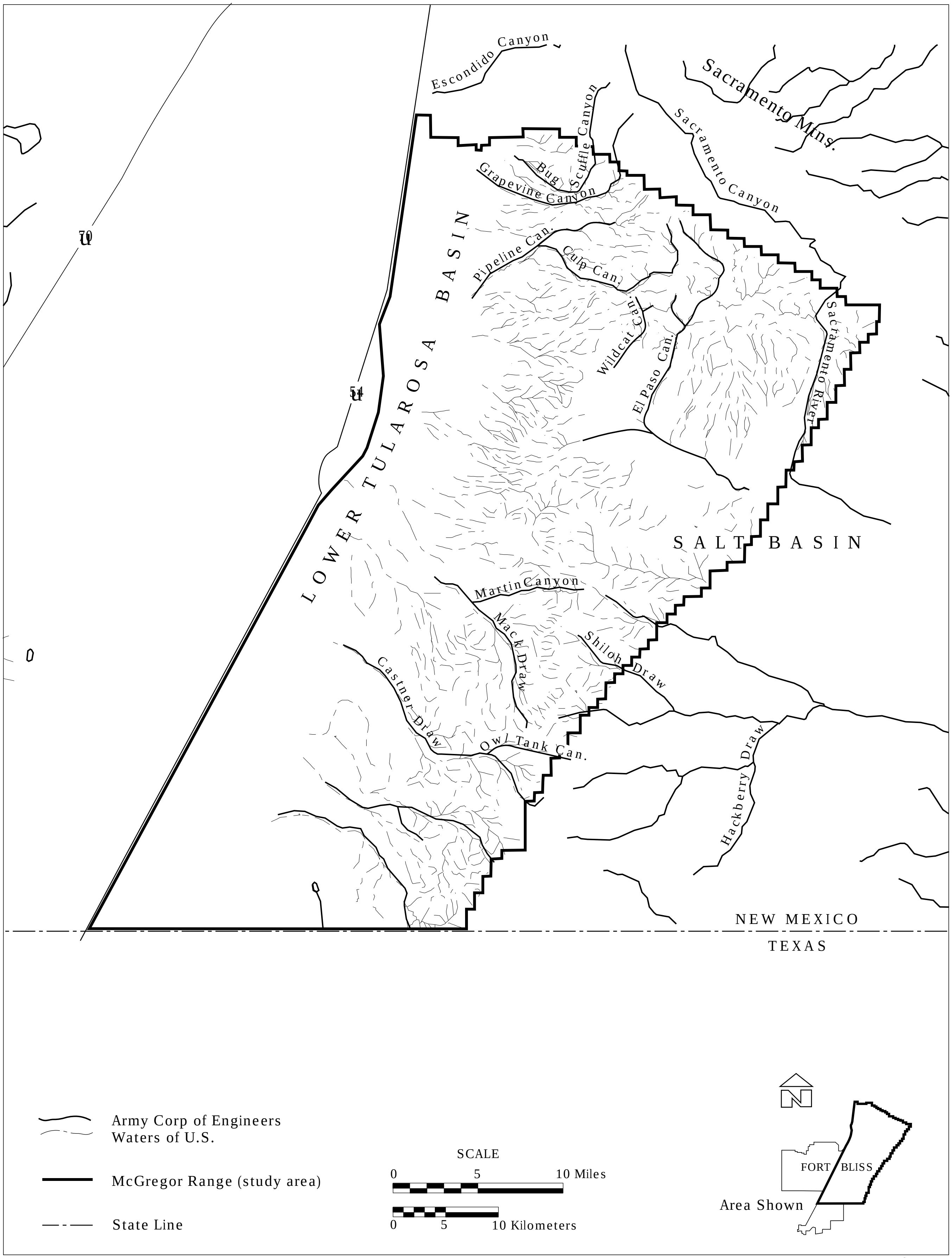

Figure 3.7-1. Surface Water Drainage on McGregor Range.

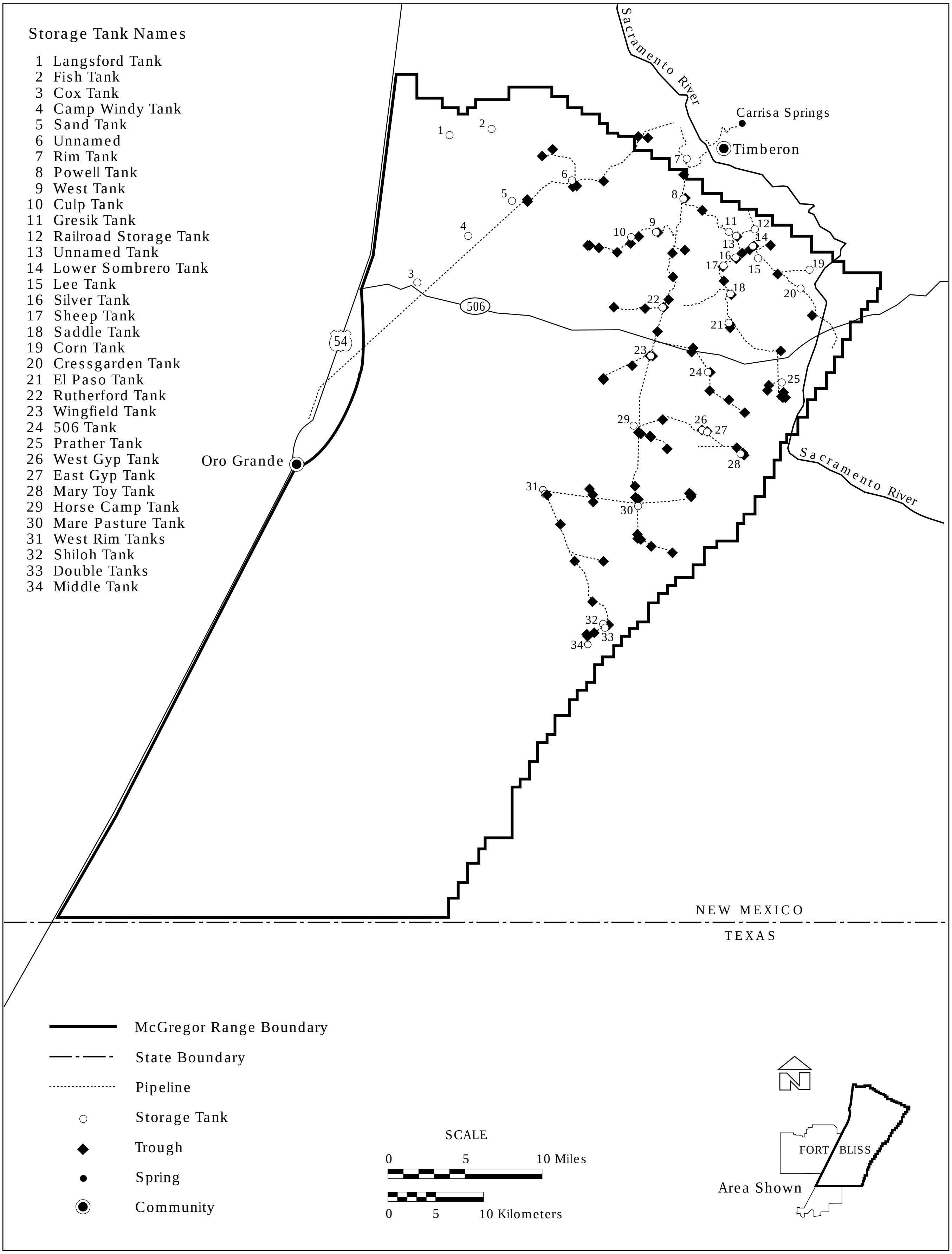

Figure 3.7-2. Water Pipelines, Storage Tanks, and Watering Troughs on McGregor Range.

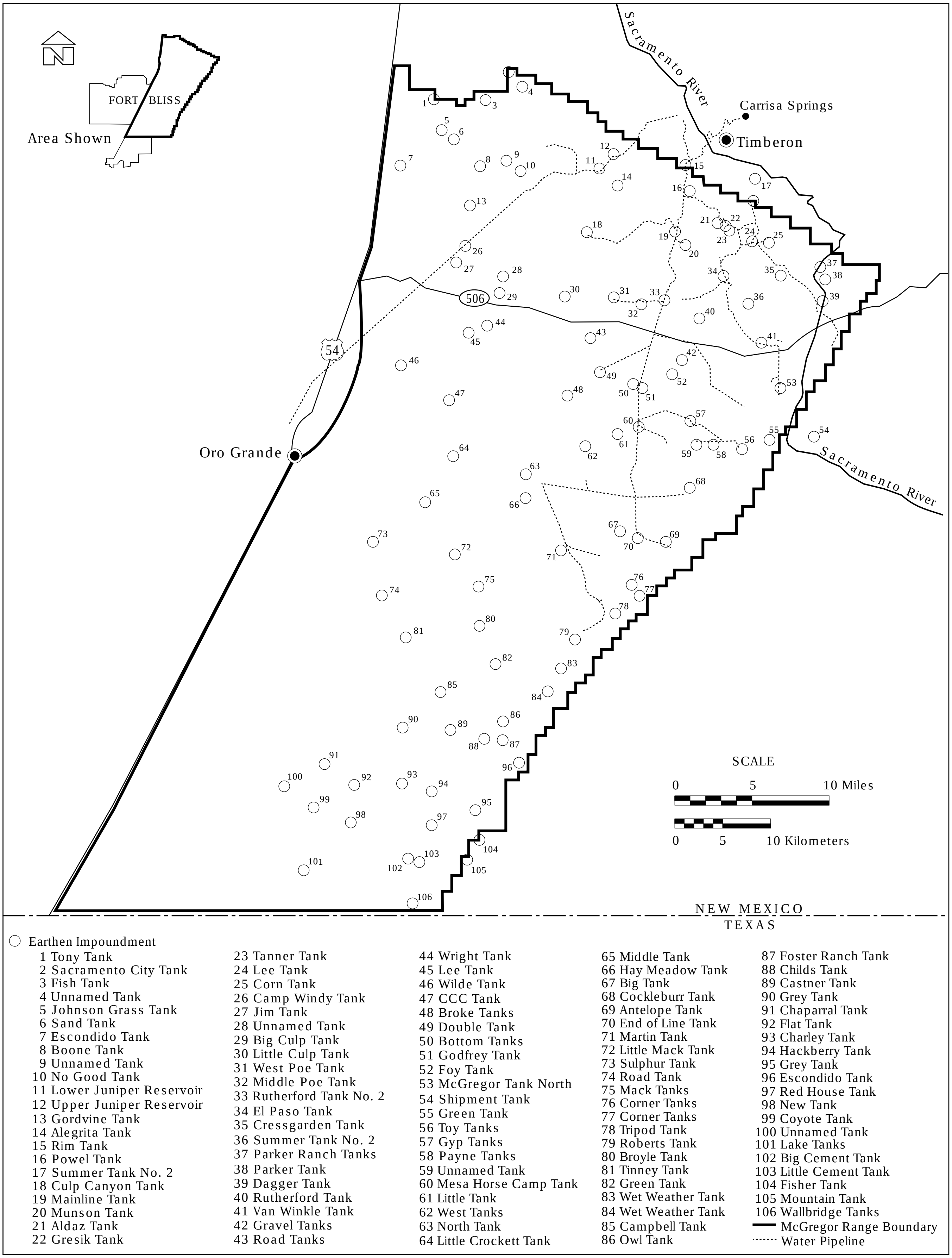

Figure 3.7-3. Water Pipelines and Earthen Impoundments on McGregor Range.

3.7.2.1 Upper Hueco Bolson

The Hueco Bolson is a downfaulted basin characterized by a series of subparallel step faults that form a deep structural bedrock trough on the west side of the basin. Many of the faults extend to the surface, where they offset basin-fill deposits. The upper Hueco Bolson contains Tertiary and Quaternary basin-fill sedimentary deposits that extend northward into the Tularosa Basin and southward into the lower Hueco Bolson. Basin-fill deposits are bounded by less permeable carbonate rocks of the Hueco Mountains and Otero Mesa escarpment to the east; by less permeable igneous, metamorphic, and sedimentary rocks of the Organ and Franklin mountains to the west; and are underlain by less permeable consolidated rocks. Data from geophysical surveys and deep test wells indicate that basin-fill deposits in the trough are as much as 8,000 feet thick (Orr and Risser, 1992). Eastward from the trough, near the front of the Hueco Mountains and the Otero Mesa escarpment, their thickness tapers to near zero.

Basin-fill deposits on the west side of the upper Hueco Bolson in New Mexico consist of approximately 1,000 feet of sand with gravel, clay, silt, and sandstone lenses. Limited data from the east side of the bolson indicate deposits are primarily fine-grained sand, silt, and clay. Throughout most of the west side of the Hueco Bolson, the percentage of clay increases with depth (Orr and Risser, 1992).

Water enters the groundwater flow system in the basin-fill deposits mostly as mountain-front recharge from storm runoff in alluvial fan areas adjacent to the Organ and Franklin mountains. Recharge on the east side of the basin is less significant, as surface water from the Hueco Mountains drains primarily to the east, and because of the fine-grained nature of the basin-fill deposits near the Hueco Mountains. Subsurface recharge also occurs as underflow from the Tularosa Basin along the northern boundary of the Hueco Bolson and from the Mesilla Bolson through Fillmore Pass between the Franklin and Organ mountains (Orr and Risser, 1992). Flow modeling by the U.S. Geological Survey (USGS) Society indicates that 3.1 percent of the precipitation falling on adjacent mountain drainage areas reaches the saturated zone. Their investigation estimated an annual recharge rate of 4,500 afy to the Hueco Bolson from the Organ and Franklin mountains. Underflows of 3,800 afy from the Tularosa Basin and 260 afy through Fillmore Pass were indicated (Orr and Risser, 1992). Based on these results, annual recharge to the upper Hueco Bolson is approximately 8,560 afy.

About 2.6 million af of fresh water may be in storage in the New Mexico part of the upper Hueco Bolson (Orr and Risser, 1992). However, the thickness of the fresh water zone in New Mexico decreases from west to east. A line representing the eastern limit of fresh-water containing less than 1,000 milligrams per liter (mg/L) of total dissolved solids (TDS) extends from near Newman at the southwest corner of McGregor Range north through the length of the basin and into the Tularosa Basin (Figure 3.7-4). The USGS (Rapp, 1958) noted that the quality of groundwater greatly improves to the southwest of McGregor Range toward the Franklin Mountains.

Evapotranspiration is not a significant component of the groundwater flow system throughout most of the northern part of the Hueco Bolson, because the depth to groundwater generally exceeds 200 feet.

Course-grained alluvial aquifers near the mountain fronts are characterized by relatively high values of hydraulic conductivity. Fine-grained alluvial deposits are characterized by relatively low hydraulic conductivity. Large ratios of horizontal to vertical hydraulic conductivity are due to discontinuous, thinly bedded clay units throughout most of the basin-fill deposits. Aquifer-test results in wells in the Upper Hueco Bolson indicate that the small ratio of vertical to horizontal hydraulic conductivity results in delayed drainage of water from overlying deposits and that, in the long-term, the storage coefficient should approach the specific yield of an unconfined aquifer (Orr and Risser, 1992).

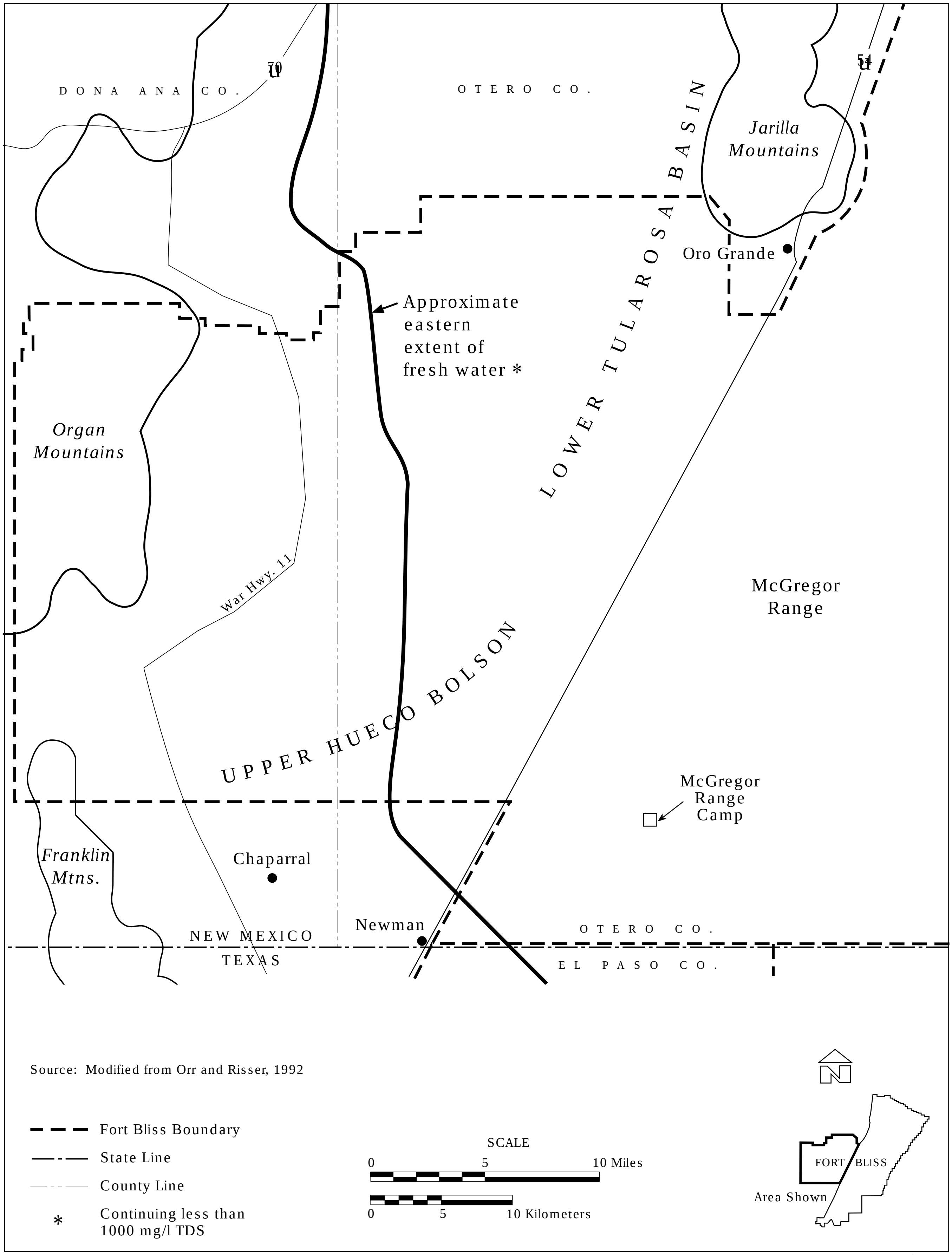

Figure 3.7-4. Eastern Extent of Fresh Water in the Upper Hueco Bolson.

Hydraulic conductivity estimates were derived from aquifer tests in wells in the western half of the Hueco Bolson. Most of these wells penetrate only the upper 1,000 feet or less of basin-fill deposits. Based upon the aquifer-test data, hydraulic conductivity estimates for the basin-fill deposits range from less than 1 to more than 200 feet per day. Transmissivities of 5,000 to 22,000 square feet per day have been reported from aquifer tests on the western side of the Hueco Bolson in Texas. Hydraulic conductivity estimates from these wells range from 15 to 43 feet per day.

Groundwater resources in the Upper Hueco Bolson of McGregor Range have not been developed extensively. A groundwater study was completed for the USGS (Rapp, 1958) to determine if a supply of 100 gpm of potable water could be developed for the McGregor Range Camp. Except for isolated areas, groundwater was too saline for human consumption, and the Army found it more economical to import El Paso city water to McGregor Range.

Fort Bliss is currently conducting an exploration program for geothermal resources at Davis Dome on McGregor Range (Luna, 1997). Geothermal water at temperatures ranging from 167 to 185°F is present at depths of 400 to 600 feet. The maximum-recorded temperature was 192°F at a depth of 2,258 feet (Mathis, 1998). Fort Bliss engineering personnel indicated that the site could produce 3 megawatts of electric power that could be used to power a desalination plant producing 7 mgd of drinking water from the saline aquifer at a significantly lower cost than Fort Bliss now pays for water (Luna, 1997). This source would be used to augment or replace water currently pumped by Fort Bliss from the Hueco Bolson in Texas.

3.7.2.2 Lower Tularosa Basin

The Tularosa Basin was formed as a structural trough during a period of Middle to Late Cenozoic faulting. The faulting exposed Precambrian through Tertiary-age igneous and sedimentary rocks along the scarps bounding the basin. These same rocks underlie Cenozoic fill deposits in the central area of the basin. Some of the Paleozoic and Mesozoic rocks are known to yield small quantities of water to wells in adjacent areas but are not considered to be major aquifers in the McGregor Range area. Deposition of alluvial fill accompanied the faulting in the Tularosa Basin. Fill deposits include sand, gravel, and clay in alluvial fans along basin margins and extensive lake, alluvial, and evaporite deposits within the interior basin. Large quantities of saline water occur within most of the Tularosa Basin sediments (Orr and Meyers, 1986). Two primary sources of groundwater are present in the lower Tularosa Basin: (a) the central basin aquifer, which consists of alluvial, wind, and lake deposits; and (b) alluvial aquifers at the mouths of major canyons on the valley perimeter.

The central basin aquifer is characterized by lake deposits with lesser amounts of alluvial and wind deposits. While large quantities of water are available in this unit, the quality of the water is poor and generally unsuitable for public consumption without treatment. Evaporate deposits in the central basin may contain large amounts of very saline water.

The alluvial aquifers consist of course to fine-grained sediments in a series of coalescing alluvial fans along the margins of the basin. These fans were formed from detritus derived from source areas in the bordering mountains. The sizes of the fans vary, depending on the size of their respective drainage areas. The fan deposits occur in the subsurface as pediment deposits or thin veneers overlying bedrock and as thicker units basinward, where they intertongue with central basin deposits (Orr and Meyers, 1986).

The thickness of alluvial fan deposits ranges from less than 100 feet on the higher step-faulted blocks adjacent to the Sacramento escarpment to about 4,000 feet in the central areas of the basin. Surficially, these deposits are characterized by very coarse, poorly sorted sediments adjacent to the mountain front and by well-sorted, increasingly fine-grained sediments basinward. Abrupt lithologic changes occur at the surface in places where lenticular beds of gravel and sand grade horizontally to silt and clay (Orr and Meyers, 1986).

Water enters the groundwater flow system in the lower Tularosa Basin principally as mountain-front recharge from storm runoff in alluvial fan areas adjacent the mountains. Models used by the USGS in the Franklin and Organ mountains indicate that 3.1 percent of the precipitation falling in the Organ Mountains drainage areas reaches the saturated zone (Orr and Risser, 1992). Surface drainage areas in the Organ Mountains, that contribute water to the lower Tularosa Basin, encompass about 225 square miles. If the average annual precipitation over this area is 12 inches and actual recharge to the basin-fill is 3.1 percent of the precipitation that falls on the mountain drainage area, recharge to the western part of the Tularosa Basin is about 4,460 afy (U.S. Army, 1998f).

Potentiometric surfaces in wells on the east margin of the Tularosa Basin reveal the presence of groundwater ridges in proximity to the mouths of major canyons. Such ridges in the water table indicate recharge to the aquifer by infiltration of surface flow. Alluvial fan sediments west of the Sacramento Mountains, from the mouth of Grapevine Canyon to beyond the northern boundary of McGregor Range, were found to be saturated with fresh water in a zone about 3 miles wide and from 0- to about 1,400-feet thick. The USGS (Orr and Meyers, 1986) estimated 1.4 to 2.1 million af of fresh water in storage in the area from Grapevine Canyon to Escondido Canyon (about 3 miles south of Alamogordo). An additional 3.6 to 5.4 million af of slightly saline water may be in storage in the same area. Movement of groundwater is westerly, toward the center of the basin, at a gradient of 10 to 50 feet per mile. The investigation did not extend southeast of Grapevine Canyon, and it is not known how far similar hydrologic conditions may extend in that direction. Recharge from the Sacramento Mountains to the eastern part of the Tularosa Basin is estimated at 4,500 afy (U.S. Army, 1998f).

Evapotranspiration in the Tularosa Basin is not a significant component of the groundwater flow system because the depth to groundwater generally exceeds 200 feet.

The estimated fresh-water hydraulic conductivities of alluvial fan deposits and basin-fill deposits in the lower Tularosa Basin range from 1 to more than 300 feet per day. However, because of the higher viscosity of saline water, the saline-water hydraulic conductivity is less than that of similar fresh-water aquifers. Water levels in these deposits respond to short-term pumping stress as if under leaky-confined conditions probably because the interbedded clays restrict the vertical flow of water. Under long-term stress, the storage coefficient in alluvial deposits should approach the specific yield, which has been estimated at 15 to 20 percent. Saturated sand units comprise roughly 3 to 26 percent of the basin-fill sediments. The hydraulic conductivities of such sand units may be about 1 foot per day, and the units probably respond to stress as leaky-confined aquifers (Orr and Meyers, 1986). Groundwater development in the Tularosa Basin area of McGregor Range, except for a few livestock wells, has not been extensive, primarily because of the salinity of the water.

3.7.2.3 Western Salt Basin

Middle Cenozoic block faulting in the Otero Mesa area of the Salt Basin exposed Paleozoic and Mesozoic carbonate rocks, but did not produce the downfaulted blocks and alluvial fill that are characteristic of the Tularosa Basin. The carbonate rocks are known to yield small quantities of saline water (the source of the basin name), but are not considered to be major aquifers. Course- to fine-grained sediments form a series of coalescing alluvial fans along the north margin of the Salt Basin. The fans contain detritus derived from source areas in the bordering Sacramento Mountains (Orr and Meyers, 1986).

In general, groundwater developed from the Paleozoic and Mesozoic formations in the basin ranges from brackish to saline. These formations are not believed to be a likely source for development of a potable water supply. However, fresh-water bearing sediments on the east side of the Tularosa Basin near Grapevine Canyon probably extend into the alluvial areas south of the Sacramento Mountains (McClean, 1970). The thickness of fan deposits saturated with fresh water (containing less than 1,000 mg/L TDS) is estimated to range from 0 to as much as 1,400 feet. Saturated sediments include poorly sorted boulders, sand, and silt near fan apexes, to silt and clay near the base of the fans (Orr and Meyers, 1986). Additional work needs to be done in that area to determine the presence of a fresh-water aquifer and the size of its likely recharge area. The brackish to saline groundwater in the carbonate rocks of Otero Mesa flows easterly toward the center of the Salt Basin (Orr and Meyers, 1986).

Groundwater resources are not extensively developed in the Salt Basin, and no significant use of groundwater occurs in the basin within McGregor Range. A few small-capacity stock and domestic wells have been completed on Otero Mesa. However, the possibility of a fresh water aquifer in the alluvium south of the Sacramento Mountains represents a potential resource for nondomestic use in that area of McGregor Range.